Terrestrial water storage in wildfire forecast

Dinuka Kankanige [a], **Yi Liu** [a], **Ashish Sharma** [a]

[a] *School of Civil and Environmental Engineering, University of New South Wales, Sydney, 2052, Australia.*
Email: d.kankanige@unsw.edu.au

Abstract: Gravity Recovery and Climate Experiment (GRACE)-based terrestrial water storage is effectively used in a number of hydrological applications worldwide. The link between terrestrial water storage and wildfires remains unclear due to the limited use of such data in wildfire-related applications, which is mainly hindered by the estimate's coarse spatial and temporal resolution. However, terrestrial water storage estimate from GRACE makes an advanced indicator of water stress, surpassing other conventional moisture indicators. Terrestrial water storage provides an integrated measure of the surface, subsurface, and deep-water levels which improves its potential to capture the hydrological dynamics leading to wildfires.

Formulations designed for fire risk estimation often carry a lot of limitations which are unaddressed. Time series fire forecasting models often use historical thermal anomaly series that do not always provide true fire detection. Fire ratings provided by various fire danger systems have major limitation of accounting for time varying fuel load using simplified techniques, adapting generalized complex fuel types, and relying on fuel load assumptions. Also, these systems involve soil moisture as an indicator of fuel availability. Soil moisture is highly heterogeneous varying with soil type, soil depth, topography, and vegetation cover, and may not sufficiently capture the water stress or the rootzone conditions critical for fuel build up. Machine learning models carry complexities where the mechanisms underlying the fire ignition are unexplained, and they also involve the combined effect of meteorological factors and fuel availability but are devoid of direct indicators of water stress.

In this background, we examine the potential contribution of terrestrial water storage in fire risk prediction. Given the fire-prone vegetation types and diverse climate zones, the study is based on an application to Australia. Regression models involving historical fire risk information and terrestrial water storage data as predictors, are compared against models not inclusive of terrestrial water storage. The results indicate that terrestrial water holds promise as a predictor of fire risk in terms of coarse resolution data (Figure 1), suggesting that further improvements could be achievable at higher resolution, a key direction for future research. As a fire-prone land, Australia presents a strong case for leveraging these insights into region-specific fire risk predictions.

Keywords: *Water stress, terrestrial water storage, fire risk*

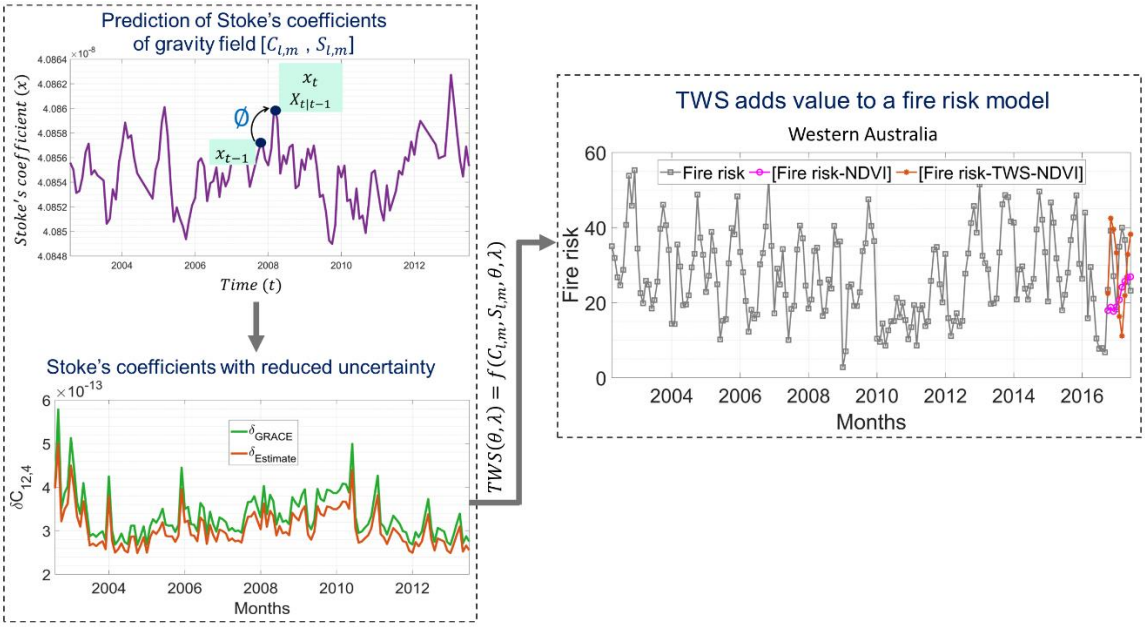

Figure 1 The workflow from gravity field data to terrestrial water storage (TWS), and their integration into fire risk modelling